



# UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/627,418	07/27/2000	Tatsuya Usami	00N010-US	1182
21254	7590	08/24/2005	EXAMINER	
MCGINN & GIBB, PLLC 8321 OLD COURTHOUSE ROAD SUITE 200 VIENNA, VA 22182-3817			QUACH, TUAN N	
			ART UNIT	PAPER NUMBER
			2826	

DATE MAILED: 08/24/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

82

<b>Office Action Summary</b>	Application No. 09/627,418	Applicant(s) USAMI, TATSUYA	
	Examiner Tuan Quach	Art Unit 2826	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 12 May 2005.
- 2a) ☒ This action is **FINAL**.                      2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 28-58 is/are pending in the application.
- 4a) Of the above claim(s) 52-56 is/are withdrawn from consideration.
- 5) ☒ Claim(s) 38 is/are allowed.
- 6) ☒ Claim(s) 28-37, 39-50, 57 and 58 is/are rejected.
- 7) ☒ Claim(s) 51 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All    b) ☐ Some \*    c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)  | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

### DETAILED ACTION

Claims 1-27 are cancelled. New claims 52-58 are added. Newly submitted claim 52-56 directed to an invention that is independent or distinct from the invention originally claimed for the following reasons: these claims correspond to a method of making a semiconductor device, thus accordingly would be grouped together with group II, process claims in the Restriction made in Paper No. 3, mailed July 11, 2001.

Since applicant has received an action on the merits for the originally presented invention, this invention has been constructively elected by original presentation for prosecution on the merits. Accordingly, claims 52-56 are withdrawn from consideration as being directed to a non-elected invention. See 37 CFR 1.142(b) and MPEP § 821.03.

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was

Art Unit: 2826

not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 32-37 and 58 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lopatin or Avanzino taken with the admitted prior art and any of Yamazaki, Morisaki, or Nakano.

Re claims 32 and 58, Lopatin (6,096,648) teaches, e.g., column 4 line 60 to column 6 line 61, Figs. 1-8, teaches multilevel interconnection including copper 24 and low dielectric constant layer, e.g., layer 30 including HSQ and FLARE, similar materials employed by applicant, thus possessing the ability that Cu is unlikely to enter, the same material employed consistent with applicant's acknowledgement on page 12 lines 1-2 that it is obvious that HSQ has properties of preventing diffusion of Cu and since Lopatin does not show any diffusion. In any event, the material therein is clearly capable of such characteristics since it is the same or similar material used by applicant.

Avanzino (6,121,150) teaches copper interconnect in multilevel interconnection employing low dielectric organic based such as HSQ, parylene. See column 8 line 45 to column 11 line 27, Figs. 1-3(E). The inherent ability would be obvious for the same reasons delineated.

Although the Office is not equipped to measure the particular copper concentration and Lopatin or Avanzino do not recite the particular Cu concentration regarding  $10^{19}$  atoms/cm<sup>3</sup> as in claim 32, such would be encompassed therein since Lopatin or Avanzino are not limited or constrained as to the particular concentration.

Art Unit: 2826

Such would have been further obvious or inherent in these references given they employ the same processing to form the copper, e.g., plating, column 5 line 20 et seq. In Lopatin, column 10 line 56 in Avanzino, see instant specification, page i lines 1-2. Regarding claims 33 and 36, although the Office is not equipped to measure such concentration, the limitation therein would be inherent and obvious given that the material employed in Lopatin, e.g., HSQ or FLARE, or in Avanzino, delineated above, clearly capable of preventing copper diffusion.

Regarding the newly added limitations in claim 32 regarding the wiring separation distance between Cu wirings to a minimum distance for separation", to the extent such is supported by the disclosure, page 9, line 8-9, and page 16 line 16-18, regarding minimum interval between adjacent Cu wiring lines of 0.2 to 0.3  $\mu\text{m}$ , such would have been conventional and obvious as taught by Yamazaki, Nakano, and Morisaki. In particular, Moriasaki, 6,566,756 B1, teaches column 1 lines 59-60 the conventional LSI having desired rule wherein wiring patterns are laid in interval of 0.2  $\mu\text{m}$ ; Nakano, 6,423,651 B1, column 9 lines 21-23 teaches distance between wiring lines of 0.2  $\mu\text{m}$ ; Yamazaki 6,323,142 B1, teaches LSI wiring interval between 0.2 and 0.4  $\mu\text{m}$ . Accordingly, the selection of a distance between wirings to be 0.2 to 0.3  $\mu\text{m}$  or the separation distance approaches a minimum would have been conventional and obvious as corresponding the intervals commonly employed as amply evidenced.

Regarding claim 34, the insulating layer comprises HSQ is clearly taught as delineated above. Regarding claims 35 and 36, the thickness selection would have been obvious and would have been within the purview of one skilled in the art and given

Art Unit: 2826

that Lopatin is not limited in its thickness, the thickness taught in Avanzino above, e.g., column 10 line 2, and as 50 nm corresponds to the conventional thickness range for the insulating material,. The direct contact as in claim 37 would have been obvious as shown, e.g., Fig. 7 in Lopatin, and in any event where the adhesion/or barrier is optionally not employed or required.

Claim 38 is allowed as it was previously objected to and now rewritten accordingly.

Claims 39-50 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lopatin or Avanzino taken with the admitted prior art and any of Yamazaki, Nakano, or Morisaki as applied to claims 32-37 above, and further in view of Zhao.

Regarding claims 39-41, 44, 45, 48, 50 it would have been obvious to have included additional layers, e.g., silicon nitride sandwiching the low-k dielectric, including SiN, to have employed such structure on copper lines, and to repeat such structures to the desired levels since such correspond to well known structures as admitted, e.g., instant Fig. 9, instant specification pages 1-3, and as shown in Zhao, 6,037,664, Fig. 12, column 5 line 20 to column 9 line 40, including the conventional use of separation, e.g., layer 13, 15, column 6 lines 65 et seq., including material such as silicon nitride, wherein such layer serves useful purposes such as capping or etchstop. In any event, such layers are well known as admitted by applicant.

With regard to the adhesion layer and W as such layer in these claims, such would have been conventional and obvious given that the layers in Lopatin and Avanzino clearly capable of adhering, e.g., layer 54, and in Avanzino, layer 11, column

Art Unit: 2826

10 line 54-68 evidencing the various materials as adhesion and barriers including refractory metals thus encompassing tungsten. Additionally, Zhao (6,037,664) teaches various the conventional use of liner in conjunction with copper wherein the barrier also provides adhesion, including the use of tungsten for such material, see column 4 line 52 to column 5 line 33. The provision of openings 24 and 25 in various low dielectric constant material, e.g., layer 14, followed by copper conductor, e.g., 29 including barrier/adhesion is also shown. See column 6 line 10 to column 8 line 45.

It would have been obvious to one skilled in the art at the time the invention was made in practicing the above invention to have included the tungsten barrier/adhesion layer in question if desired to improve adhesion/barrier characteristic in the copper interconnect as evidenced by Zhao.

Claims 28-31 and 57 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lopatin or Avazino taken with the admitted prior art and any of Yamazaki, Nakano, or Morisaki above and further in view of Zhao or Subramanian.

Re claims 28, 57, Lopatin (6,096,648) is applied as above and teaches, e.g., column 4 line 60 to column 6 line 61, Figs. 1-8, teaches multilevel interconnection including copper 24 and low dielectric constant layer, e.g., layer 30 including HSQ and FLARE, similar materials employed by applicant, thus possessing the ability that Cu is unlikely to enter, the same material employed consistent with applicant's acknowledgement on page 12 lines 1-2 that it is obvious that HSQ has properties of preventing diffusion of Cu and since Lopatin does not show any diffusion. In any event,

Art Unit: 2826

the material therein is clearly capable of such characteristics since it is the same or similar material used by applicant.

Avanzino (6,121,150) teaches copper interconnect in multilevel interconnection employing low dielectric organic based such as HSQ, parylene. See column 8 line 45 to column 11 line 27, Figs. 1-3(E). The inherent ability would be obvious for the same reasons delineated.

Although the Office is not equipped to measure the particular copper concentration and Lopatin or Avanzino do not recite the particular Cu concentration regarding  $10^{19}$  atoms/cm<sup>3</sup> as in claim 28 (claim 32 above), such would be encompassed in therein since Lopatin or Avanzino are not limited or constrained as to the particular concentration. Such would have been further obvious or inherent in these references given they employ the same processing to form the copper, e.g., plating, column 5 line 20 et seq. In Lopatin, column 10 line 56 in Avanzino, see instant specification, page i lines 1-2. Regarding claims 29-31, although the Office is not equipped to measure such concentration, the limitation therein would be inherent and obvious given that the material employed in Lopatin, e.g., HSQ or FLARE, or in Avanzino, delineated above, clearly capable of preventing copper diffusion.

Regarding the newly added limitations in claim 28 regarding the separation of wirings to be 0.2 to 0.3  $\mu\text{m}$  (or in claim 32 as discussed above regarding the wiring separation distance between Cu wirings to a minimum distance for separation"), to the extent such is supported by the disclosure, page 9, line 8-9, and page 16 line 16-18, regarding minum interval between adjacent Cu wiring lines of 0.2 to 0.3  $\mu\text{m}$ , such would



Art Unit: 2826

have been conventional and obvious as taught by Yamazaki, Nakano, and Morisaki. In particular, Moriasaki, 6,566,756 B1, teaches column 1 lines 59-60 the conventional LSI having desired rule wherein wiring patterns are laid in interval of 0.2  $\mu\text{m}$ ; Nakano, 6,423,651 B1, column 9 lines 21-23 teaches distance between wiring lines of 0.2  $\mu\text{m}$ ; Yamazaki 6,323,142 B1, teaches LSI wiring interval between 0.2 and 0.4  $\mu\text{m}$ .

Accordingly, the selection of a distance between wirings to be 0.2 to 0.3  $\mu\text{m}$  or the separation distance approaches a minimum would have been conventional and obvious as corresponding the intervals commonly employed as amply evidenced.

Regarding claim 30, the insulating layer comprises HSQ is clearly taught as delineated above. Regarding claim 31, the thickness selection would have been obvious and would have been within the purview of one skilled in the art and given that Lopatin is not limited in its thickness, the thickness taught in Avanzino above, e.g., column 10 line 2, and as 50 nm corresponds to the conventional thickness range for the insulating material.

Claim 51 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. The prior art does not appear to show all the claimed limitations.

Applicant's arguments with respect to claims 28-37 and 39-51, and 57-58 have been considered but are moot in view of the new ground(s) of rejection.

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP

Art Unit: 2826

§ 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to examiner Tuan Quach whose telephone number is 571-272-1717. The examiner can normally be reached on M-F from 8:30 AM to 4:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor Nathan Flynn, can be reached on 571-272-1915. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should

Art Unit: 2826

you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

A handwritten signature in black ink, appearing to read 'Tuan Quach', with a stylized, cursive script.

**Tuan Quach**  
**Primary Examiner**